sinadder 3

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RCS SVC TRK #9

INSTRUCTION MANUAL

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HELPER INSTRUMENTS CO.

SINADDER 3

Specifications:

Panel Controls:	push-push power switch; push/AC VOLTS – push/SINAD switch; rotary AC VOLTS range switch; 1 Khz tone output level control; internal speaker level control.
Input:	permanently affixed shielded test cable w/miniclips.
SINADDER Input Level:	20 mv. to 10 VRMS
SINADDER Input Impedance:	100K ohm
SINADDER Accuracy:	± 1 dB
AC Voltmeter Ranges:	Nine: 10 mv, 30 mv, 100 mv, 300 mv, 1 V, 3 V, 10 V, 30 V 100 V.
AC Voltmeter Input Impedance:	1 Megohm
AC Voltmeter Accuracy:	± 3% of full scale ± 0.25 dB, 100 Hz to 20 Khz
Audio Amplifier:	in SINADDER mode, AGC controlled constant volume to internal speaker. in VOLTMETER mode, range switch and front panel pot control volume.
Internal Tone:	1000 Hz ± 1 Hz. 1.5 VRMS into 600 ohm load. Front panel controlled.
Power:	115/230 VAC Strap selectable 50/60 CPS ± 15% 13.5 VDC ± 15%
Size:	8.75" W x 3.25" H x 7" D

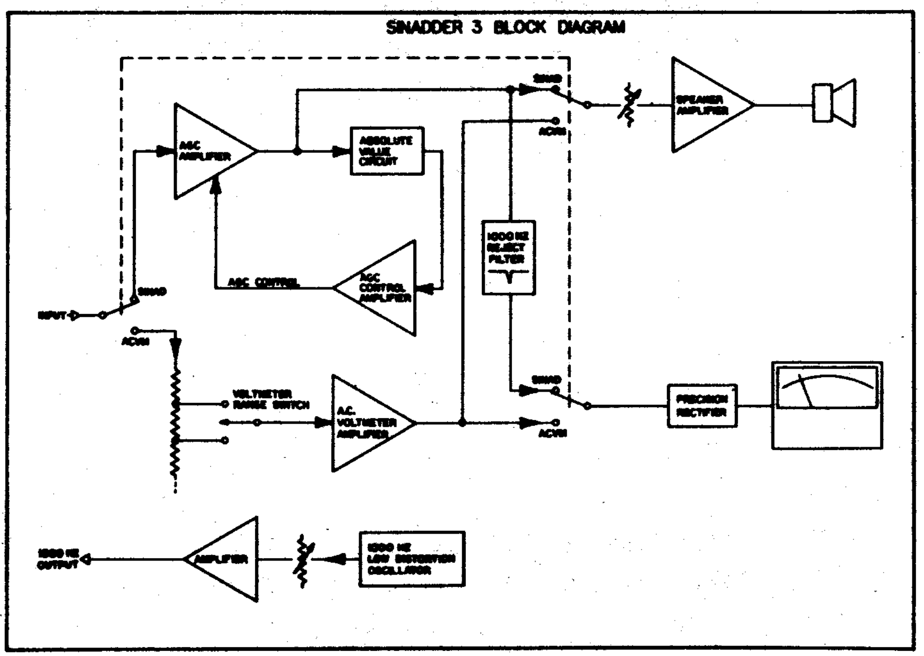


Figure 1

SINADDER 3

General Description

The SINADDER 3 contains three basic instrument functions in one product:

1. SINADDER^{tm}: A specialized distortion meter for making SINAD measurements on radio receivers. Special circuit design speeds and simplifies SINAD measurements by eliminating all distortion meter adjustments.

The null circuits of the SINADDER are internally set to the 1,000 Hz tone used for SINAD measurements, and an automatic gain control circuit eliminates the need for setting input gain to the meter. The automatic gain control feature permits the SINADDER to be used as a receiver alignment aid, providing rapid alignment of receivers for optimum performance.

2. AC VOLTMETER: A high impedance audio frequency voltmeter, with nine ranges, from 10 millivolts full scale to 100 volts full scale. Input impedance is 1 megohm, and a D.C. blocking condenser is provided.

3. LOUDSPEAKER AUDIO MONITOR: An audio amplifier, with loudspeaker and gain control permits audio monitoring of signals connected to the audio voltmeter, and of receiver audio when using the SINADDER function.

4. 1,000 Hz OSCILLATOR: A low distortion, 1,000 Hz oscillator is included. The oscillator may be used as a signal generator modulation source for SINAD measurements, for a transmitter modulation test source, signaling and other uses. Oscillator output voltage is front panel controlled up to one volt RMS.

Circuit Description

SINADDER MODE (SINAD BUTTON IN): Refer to the block diagram in Figure 1. The input circuits of the SINADDER 3 are connected to the audio output circuits of the receiver being tested. The signal appearing at the input to the SINADDER 3 consists of the wanted 1,000 cycle "Signal" frequency, and other frequencies representing the noise and distortion created in the receiver. This composite Signal, Noise, and Distortion signal is amplified by an AGC amplifier which uses an absolute value circuit in the control circuit. The output of the AGC amplifier is a replica of the input signal, but is at a constant average level, regardless of input signal level changes from 10 millivolts to 10 volts RMS.

The composite, constant level signal, is then fed into a 1,000 cycle reject filter, which removes the 1,000 cycle "Signal" component, leaving only the Noise and Distortion components. These components are amplified and rectified by a precision average value rectifier circuit and then used to drive the indicator meter. Since the input signal to the reject filter is held constant, the meter can be directly calibrated in SINAD values.

Normally, the SINADDER 3 is connected to the loudspeaker terminals of the receiver under test. The 10 volts RMS maximum input will accommodate audio power levels up to 31 watts into a 3.2 ohm speaker. On the low side, the 10 millivolts RMS permits the connection to be made as early in the circuit as the discriminator output. For Quantitative SINAD measurements, the connection must be made after the de-emphasis circuit, but connections ahead of the de-emphasis circuit will give meaningful relative readings.

AC VOLTMETER MODE (AC VOLTS BUTTON IN): Again, refer to the block diagram in Figure 1. In this mode, the test leads are connected to the voltmeter range attenuator, which is the front panel control for setting the desired full scale range of the voltmeter. Incoming audio signals are reduced in level by the range attenuator, then amplified by the A.C. Voltmeter Amplifier, then further amplified and rectified by the Precision Rectifier circuit, the output of which drives the meter.

AUDIO MONITOR: The loudspeaker monitor amplifier is functional in either the SINAD function of the AC volts function. When the instrument is set for SINADDER operation, the output of the SINADDER AGC Amplifier is connected to the audio monitor input. Since the AGC Amplifier maintains its output at a fixed level, the signal heard in the loudspeaker will be constant in volume even though the input signal from the receiver under test varies greatly.

When the instrument is set for AC Voltmeter operation, the output of the Voltmeter amplifier is connected to the audio monitor input. When the Voltmeter range selector switch is set for the proper voltage range to read the input signal, it also sets the input to the audio monitor to an appropriate level.

Regardless of whether the instrument is in the SINADDER or the AC VOLTMETER function, the volume heard in the loudspeaker can be set to the desired level by the front panel speaker volume control.

If you turn the signal generator up to a strong, noise free signal, if the receiver has low distortion, and if the generator and receiver agree on channel frequency, the SINADDER meter indicator will swing substantially to the left of the 20 dB mark on the meter scale. If you remove the signal from the receiver, and set the squelch control to let the set roar, the SINADDER meter indicator will swing within about 1 dB of the 0 dB scale mark. To determine the 12 dB SINAD sensitivity of the receiver, adjust the signal generator output attenuator until the SINADDER indicates 12 dB. The microvolts output of the signal generator is the 12 dB SINAD sensitivity of the receiver.

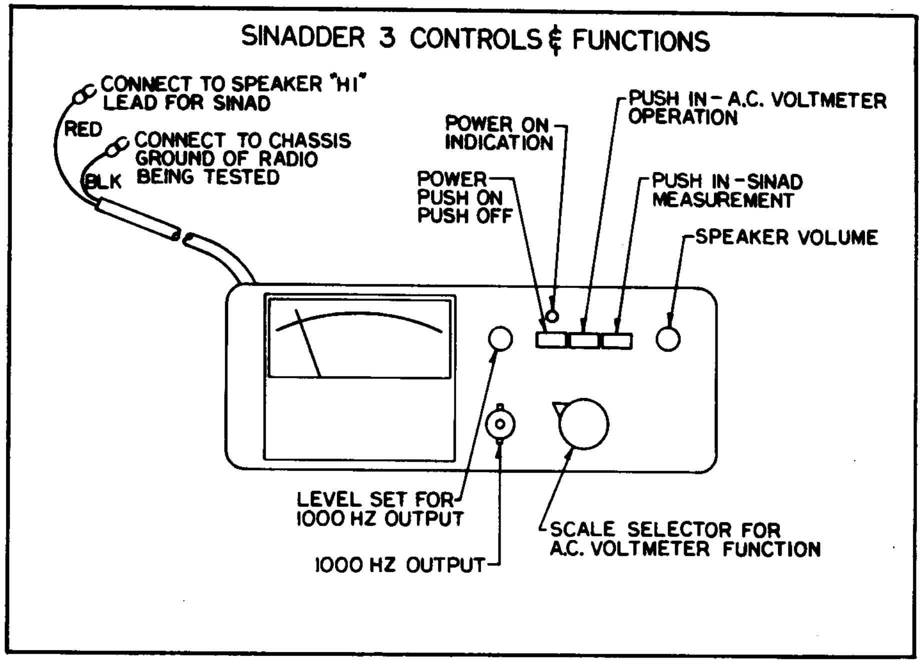


Figure 2

Operating Instructions

Refer to Figure 2, the Operating Controls.

SINAD MEASUREMENT: If you are not familiar with SINAD measurements, be sure to read the section "A FEW WORDS ABOUT SINAD MEASUREMENTS", beginning on page 8.

Before using the SINADDER 3 with a specified signal generator, check the 1,000 Hz modulating tone of the generator to be certain it is accurate enough to fall in the center of the SINADDER 3's null circuit. To do this, simply connect the modulating signal to the SINADDER 3 test leads, push in the SINAD function switch and see if the SINADDER 3 meter indicator goes below the second minor scale division on the "10" scale. If your generator's oscillator is not accurate enough, use the 1,000 Hz generator in the SINADDER 3 as an external modulation source. Connect the signal generator modulation input jack to the 1,000 Hz output jack on the SINADDER 3. (1,000 Hz output level can be adjusted by the "1000 Hz" control on the SINADDER 3 panel.)

Now, for the SINAD measurement: Connect the leads from the SINADDER 3 to the loudspeaker output of the receiver, with the black lead going to the speaker ground terminal. Connect the signal generator to the receiver and set its modulation and frequency as shown in Figure 2. That's all there is to it; the SINADDER 3 is now measuring SINAD for you.

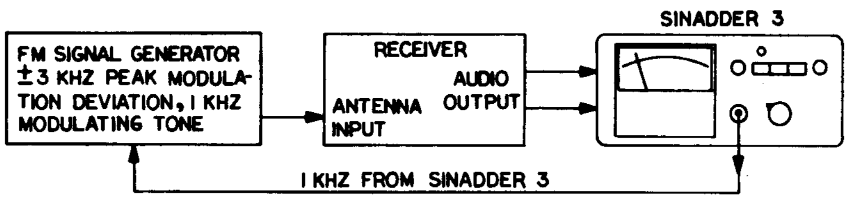
Now that you have measured the receiver's sensitivity with the SINADDER, don't stop there! Odds are you can improve the sensitivity by a few dB just by touching up the front end alignment adjustments, using the SINADDER as an indicator of optimum performance.

Set the signal generator level so the SINADDER reads about 12 dB. Then adjust the various front end adjustments to make the meter swing as far to the left as you can. If you get below the 20 mark, reduce signal generator output to bring the meter reading back to about 12 dB. Even though a receiver has been accurately aligned using the traditional limiter meter methods, this touch-up of the front end section will typically gain an improvement in sensitivity.

Ever have a receiver in the shop that seemed to need realignment, but you were afraid to try it without an instruction manual? You can do the realignment with the SINADDER. Just set the signal generator to about the 12 dB SINAD reading, and tweak away at the alignment screws. If you don't move any adjustment very far from its original setting, you won't go wrong. But watch out for sets with AFC circuits. If your realignment doesn't leave the AFC voltage properly centered, the receiver may "rest" off to one side of the channel.

Try using the SINADDER for alignment of a few receivers. Once you have gained confidence in it, you will find it is a great timesaver. Receivers will leave your bench quicker, and working better.

SINAD MEASUREMENT USING THE SINADDER 3



1. Set Signal Generator precisely on channel frequency.
2. Insert strong signal into receiver and set volume to comfortable level.*
3. Decrease Signal Generator level until SINADDER reads 12 dB.
4. Signal Generator output level is the 12 dB SINAD sensitivity of the receiver.

*This is a suitable procedure for service shops and production line testing. To obtain SINAD to EIA specifications, the volume should be set to receiver's rated audio output.

Figure 3

If you are working with a receiver that is not equipped with a loudspeaker, you can audibly monitor the receiver output with the SINADDER 3 loudspeaker. Turn the front panel loudspeaker control to obtain the desired volume level. Since the audio monitor amplifier in the SINADDER 3 is fed from an AGC amplifier, you will not hear variations in loudspeaker level even though receiver output level changes radically.

AC VOLTMETER OPERATION

> WARNING: VOLTAGES WITHIN THE MEASUREMENT CAPABILITY OF THIS INSTRUMENT ARE DANGEROUS AND CAN BE FATAL. USE PROPER SAFETY PROCEDURES AT ALL TIMES. THE COMMON (GROUND) TEST LEAD IS CONNECTED TO THE CASE OF THE INSTRUMENT. WHEN THE INSTRUMENT IS PLUGGED INTO A PROPER LINE OUTLET, THE COMMON (GROUND) TEST LEAD, AND THE INSTRUMENT CASE ARE CONNECTED TO THE POWER LINE GROUND THROUGH THE GROUNDING CONNECTOR OF THE THREE WIRE LINE CORD.

To use the SINADDER 3 as an A.C. Voltmeter, push in the switch button labeled "AC VOLTS", and set the range switch to a range approximating the voltage to be measured. The black test lead is normally connected to the chassis (ground) of the equipment being tested. The red lead is then connected to the points where voltage measurements are wanted.

An internal blocking condenser permits the meter to be used for measuring the A.C. component only, of voltages which combine both A.C. and D.C. components. Do not attempt to use the voltmeter if the D.C. component exceeds 200 Volts D.C., because this will exceed the safe rating of the blocking condenser.

Waveform Effects: The deflection of the A.C. meter is proportional to the average value of the A.C. voltage being measured, while the scale is calibrated in the RMS value of a sine wave capable of causing the deflection. When waveforms other than sine waves are being measured, the voltage readings require special interpretation.

USING THE dB SCALE: The dB scale is calibrated for a reference value of 0 dB = 1 milliwatt at a 600 ohm resistance level, corresponding to .775 volts. This corresponds to the usual DBM reference. The dB calibration applies directly on the 1.0 volt scale. For each scale below the 1.0 volt scale, subtract 10 dB from the meter reading. For each scale above the 1.0 volt scale, add 10 dB to the meter reading.

When you are using the SINADDER 3 as an Audio voltmeter, you can audibly monitor the signals you are measuring with the built-in loudspeaker. Adjust the volume to a comfortable level by using the control knob in the upper right hand corner of the panel. When you switch the voltage range switch to obtain a proper meter deflection from the voltage being measured, the range switch also inserts a proper amount of attenuation into the input of the loudspeaker amplifier — thus the amplifier always receives the proper input voltages whether you are observing signals of 10 millivolt or 100 volt magnitudes.

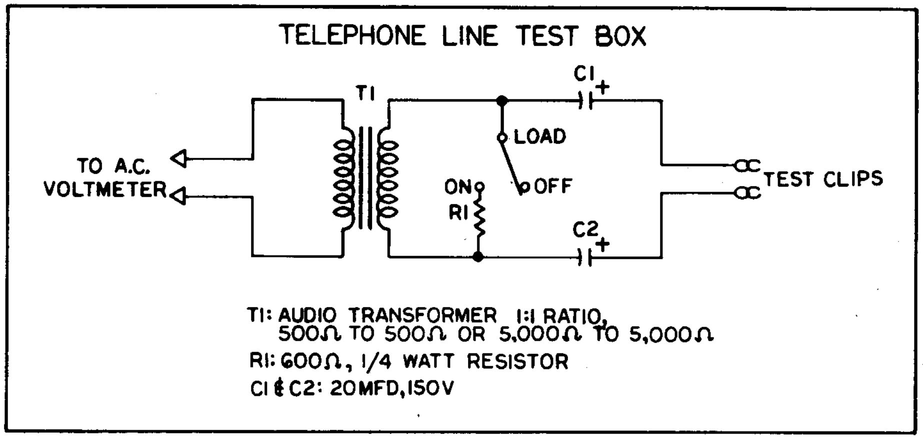


Figure 4

MEASURING AND MONITORING TELEPHONE CONTROL LINES: The SINADDER 3 is a very handy instrument for checking the telephone control lines often used to control base stations.

Proper measurement of a telephone line is done with a transformer, which prevents inserting any unbalanced ground currents into the telephone line. If the telephone line being measured is not terminated into the equipment, a 600 ohm termination resistance should be connected across the line. When D.C. signalling is used, a blocking condenser between the transformer and the line should be used to avoid shorting the control voltage.

Figure 4 shows the circuit of a simple telephone line test box that will be a big time saver. If you do much work with telephone control lines, we suggest you construct one.

The 1,000 Hz oscillator can be used to feed a telephone line with a test signal. The telephone line test box just mentioned can be used to avoid unbalancing the line, which would occur if it were connected directly to the unbalanced output of the test oscillator.

A few words about SINAD Measurements

The term SINAD is an abbreviation for the following ratio:

$$\frac{\text{Signal plus Noise And Distortion}}{\text{Noise plus Distortion}}$$, expressed in Decibels.

The signal level at which a receiver produces a 12 dB SINAD ratio is referred to as the 12 dB SINAD sensitivity of the receiver. In practice, a 12 dB SINAD signal is a reasonably intelligible and useful signal for speech transmission.

Since a SINAD measurement gives a more meaningful measure of a receiver's useful sensitivity than is obtained by other methods, it has become the preferred method of specifying and measuring receiver sensitivity in FM receivers used in land mobile and marine services.

The exact method of measuring 12 dB SINAD sensitivity is given in the Electronic Industries Association's Standard #RS-204-A*, which is quoted here:

> "a 1000 microvolt test signal from a standard input signal source with standard test modulation shall be connected to the receiver antenna input terminals. A standard output load and a distortion meter incorporating a 1000 hertz band elimination filter shall be connected to the receiver audio output terminals. The receiver volume control (low level) shall be adjusted to give rated audio output. The standard input signal level shall be reduced until the SINAD is 12 dB. At this value of signal input, the audio output shall be at least 50% of the rated audio output without readjustment of the volume control. If the audio output is less than 50% of rated audio output, the input signal level shall be increased until 50% of full rated audio output is obtained, and this value of input signal level shall be used in specifying sensitivity.
>
> **Note:** A receiver with more than one volume control shall be adjusted utilizing a control preceding the audio power amplifier."
>
> Standard RS-204-A specifies that the receiver shall be operated into a resistive load equivalent to the load into which the receiver normally operates. It also specifies standard test modulation as being 60% of the peak modulation used. (3 Khz peak for typical communications systems using 5 Khz maximum peak modulation.)

Since the SINAD definition includes the distortion created by the receiver's audio output stage, a precise measurement of SINAD should be made at the rated audio output. However, in typical equipment with low distortion amplifiers, a reasonably accurate SINAD measurement can be made with the audio output merely set at a comfortable listening level, using the loudspeaker of the receiver as the audio load.

About Accuracy

For a precise determination of the ratio implied by the SINAD definition, the measurement circuits of the distortion meter should measure the RMS values of the composite signal, noise, and distortion waves. However, almost all commercially available distortion meters are based upon average measuring, but RMS calibrated, metering circuits. At the low distortion and noise percentages involved in the typical 12 dB SINAD measurements, the error created by the use of average metering circuits instead of RMS metering circuits is negligible. The metering circuits of the SINADDER are average measuring in nature, to provide optimum correlation with commonly used distortion meters.

*Reprinted by permission. Copies of RS-204-A are available from Electronic Industries Association, 2001 Eye Street, Washington, D.C., at $5.25 per copy.

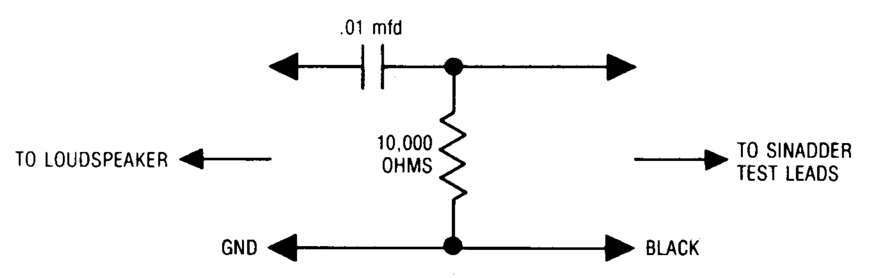
The width of the null in commercial distortion meters varies considerably from one model to another. While this will not create any discrepancy in simple distortion measurements, the width of the null will affect readings on noise measurements. Therefore perfect correlation between SINAD indications may not be obtained between different model distortion meters, although they agree perfectly on ordinary distortion measurements.

Although different model distortion meters may give slightly different SINAD readings on the same composite signal, the SINAD method of measuring receiver sensitivity is remarkably precise. This is because the 12 dB SINAD performance of a typical FM receiver falls in a place on the FM improvement curve where a small percentage change in incoming signal will create a large change in SINAD reading. Thus, distortion meters differing by two or three dB in their SINAD reading will result in 12 dB SINAD sensitivity measurements which correlate to better than 1 dB. 12 dB SINAD sensitivity measurements made with the SINADDER will correlate within 1 dB to the sensitivity measurements obtained by the use of the most popular distortion meters.

About that Meter Flicker

The flickering of the meter pointer is caused by the statistical nature of the noise in the receiver output. Since this flickering is a basic fact of nature, the only way to reduce it (and still make a true SINAD measurement) would be to slow down the meter response time. This response is, in fact, slowed down by the meter circuit, but further slowing would result in an annoying lag between an adjustment on the radio and the resulting meter indication.

When the SINADDER is used as a receiver alignment aid, the amoung of flicker can be greatly reduced by the use of an auxiliary filter circuit, connected between the loudspeaker terminals and the SINADDER test leads. See Figure 5. This filter circuit reduces the lower frequency noise components, which contribute most of the flicker. When the circuit is in use, however, the SINADDER calibration should be considered only relative, and the circuit should be removed for any quantitative measurements.



Auxiliary Filter Circuit

Figure 5

Calibration Checks:

(A) 1,000 Hz OSCILLATOR: The frequency of the 1,000 Hz oscillator can be checked using a frequency meter. If the frequency is not within 2 Hz of the 1,000 Hz, reset it using R 47.

(B) A.C. VOLTMETER: Calibration of the A.C. Voltmeter may be checked by comparing it with a known A.C. standard voltmeter. If the calibration requires correction, we suggest that a voltage value of 1 volt at 60 Hz or 1,000 Hz be used.

(C) SINADDER: Connect a 2,000 Hz audio source to the SINADDER test leads, and depress the SINAD switch. The meter indicator should swing to within plus or minus 1 dB of the dB mark, and should not move from that area as the voltage of the audio source is varied from 10 millivolts to 10 volts. If not adjust R 20 to set the meter to the 0 dB mark with the 2,000 Hz input signal set at about 1 volt. Then, connect the red test lead to the 1,000 Hz output jack on the SINADDER 3 front panel, and turn the 1,000 Hz control fully clockwise. The meter indicator should drop to a point well to the left of the 20 dB scale marking. If not, carefully adjust R 14 and R 17 for a minimum meter deflection.

12VDC REAR PANEL CONNECTION

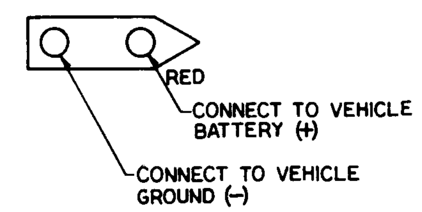


Figure 6

SCHEMATIC: SINADDER 3

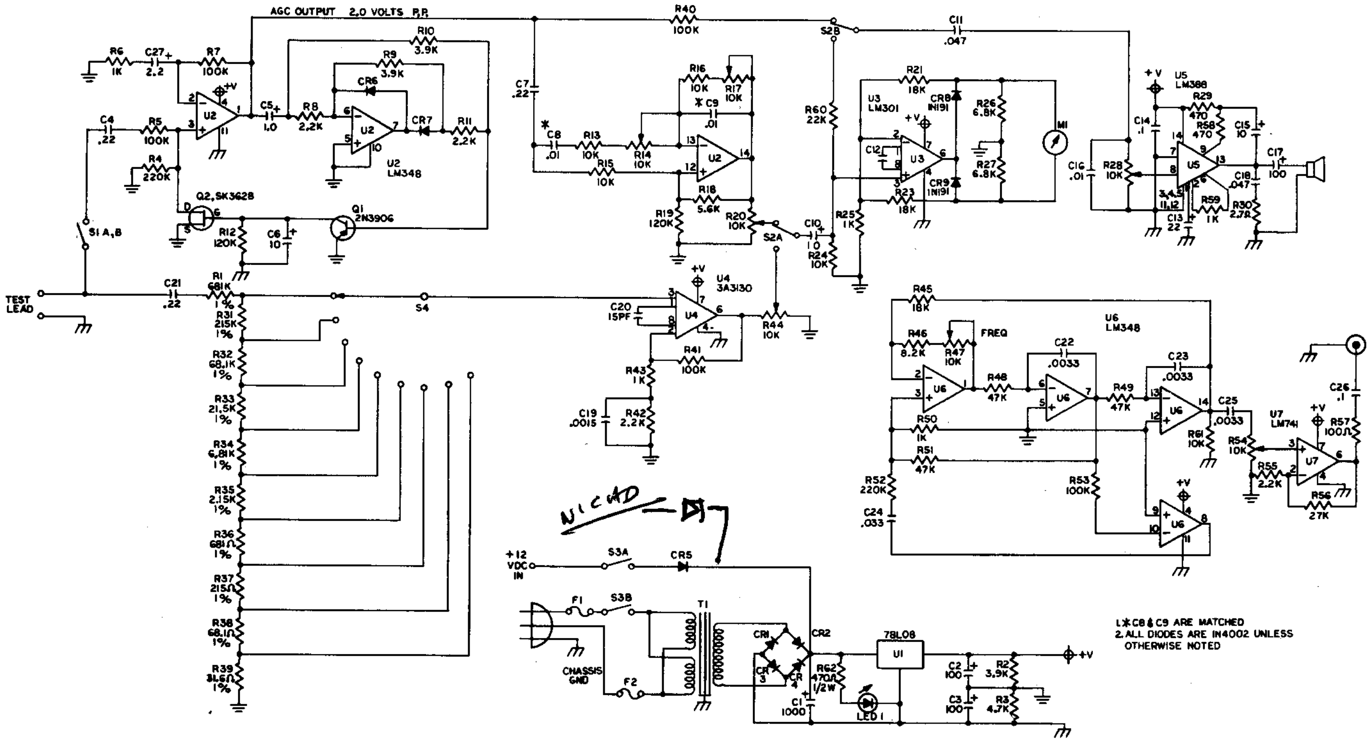


Figure 7

COMPONENT PLACEMENT

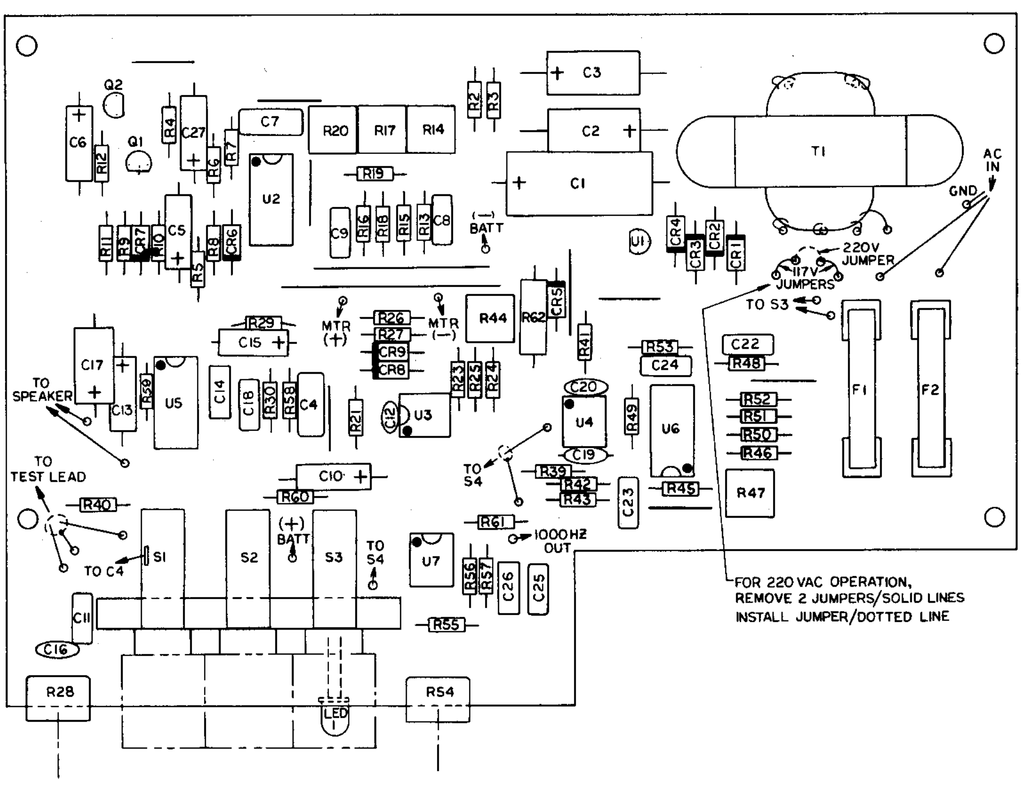


Figure 8